

ACCESSION #: 9302190334
LICENSEE EVENT REPORT (LER)

FACILITY NAME: Dresden Nuclear Power Station, Unit 3 PAGE: 1 OF 14

DOCKET NUMBER: 05000249

TITLE: Manual Reactor Scram Due to Loss of Instrument Air
Through Unit 3A IA Dryer Inlet Valve AO 3-4799-1194 and
Failure of SA/IA Cross-Tie Valve AO 3-4701-500 to Open
Timely

EVENT DATE: 01/16/93 LER #: 93-004-00 REPORT DATE: 02/16/93

OTHER FACILITIES INVOLVED: Dresden Unit 3 DOCKET NO: 05000249

OPERATING MODE: N POWER LEVEL: 083

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR
SECTION:
50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:

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COMPONENT FAILURE DESCRIPTION:

CAUSE: X SYSTEM: LD COMPONENT: V MANUFACTURER: M120
X LD RG R340
REPORTABLE NPRDS:

SUPPLEMENTAL REPORT EXPECTED:

ABSTRACT:

At 1213 hours on January 16, 1993, with Unit 3 at 83% power, a Unit 3 Instrument Air [LD] Header Pressure low Alarm was received in the Control Room [IB]. At 12:15:43, a Scram Header Low Pressure Alarm A-1 was received on the Sequence of Events Recorder (SER). Instrument Air Header pressure was observed to be decreasing rapidly. At 12:15:53, the Unit 3 NSO manually scrambled the reactor in accordance with Dresden Operating Abnormal Procedure DOA 4700-01. The Unit 2 and Unit 3 RX Building Ventilation System [VA] auto isolated and the 2/3 'B' SBT system [BH] auto started at 12:16 on a Group II Isolation. At 1219 the 2/3 'B' SBT train tripped and the 'A' train auto started.

Loss of Instrument Air is attributed to mechanical failure of the 3A

Instrument Air Compressor dryer inlet valve to close during the dryer purge cycle with concurrent failure of the backup Service Air to Instrument Air Cross-tie valve to promptly open on a low instrument air pressure signal. Corrective action include replacing the SA/IA cross-tie valve air regulator and pressure relief solenoid, replacement of the dryer inlet and purge valves and solenoid operators.

The safety significance of this event is minimal since a manual reactor scram was initiated and all safety systems performed as required. A previous un-reportable event occurred on March 10, 1990, where a dryer exhaust valve failed in an open position following valve replacement. The root cause was attributed to inadvertent reverse connection of the switching valve air supply lines.

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END OF ABSTRACT

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PLANT AND SYSTEM IDENTIFICATION:

General Electric - Boiling Water Reactor -2527 MWt rated core thermal power.

Nuclear Tracking System (NTS) tracking code numbers are identified in the text as (XXX-XXX-XX-XXXXX).

EVENT IDENTIFICATION:

Manual Reactor Scram Due to Loss of Instrument Air Through Unit 3A IA Dryer Inlet Valve AO 3-4799-1194 and Failure of SA/IA Cross-Tie Valve AO 3-4701-500 to Open Timely

A. Conditions Prior to the Event:

Unit: 3 Event Date: January 16, 1993 Event Time: 1213 Hours

Reactor Mode: N Mode Name: Run Power Level: 83%

Reactor Coolant System (RCS) Pressure: 985 psig

B. Description of Event:

On January 16, 1993, at 1213 hours, with Unit 3 operating at 83% thermal power, a Unit 3 Instrument Air [LD] Low Header Pressure

Alarm was received on Control Room Panel 923-1. The Control Room Center Desk Operator observed the panel pressure indicator at 75 psig, decreasing rapidly. At 12:14:39, an Instrument Air Pressure Low Alarm [IB] was received on the Sequence of Events Recorder (SER) [IQ]. At 12:15:43, a Reactor Building Ventilation (RBV) [VA] exhaust Fan Trip and Scram Header Low Pressure Alarm were received on the SER. At 12:15:53, the Unit 3 Nuclear Station Operator (NSO) initiated a manual scram, placed the Mode Switch to Refuel and closed the outboard MSIV's. A review of the Transient Analysis Recorder Plot (Figure 1), indicated that the Unit 3 Service Air to Instrument Air cross-tie valve started to open at 12:17:11, approximately 1 1/2 minutes following the low air pressure signal. Approximately 60 seconds following the Instrument Air Low Pressure Alarm, the SER indicated 3A Dryer Trouble, Bypass Open alarm. The bypass is set to open at 60 psig dryer discharge pressure. Approximately 2 1/2 minutes following the Instrument Air low pressure alarm, instrument air header pressure started to recover rapidly (TAR) indicating the Service Air/Instrument Air Cross-Tie valve had fully opened.

Prior to this event, a new rotary compressor had been placed in service on January 15, 1993 replacing the existing 3C reciprocating Instrument Air Compressor. Following placing the new 3C IA compressor in service, operations scheduled the Unit 2B Instrument Air Compressor to be taken out-of-service for maintenance. The 2B Instrument Air Compressor was taken out-of-service on January 16 at 1206. The Unit 2 Service Air to Instrument Air cross-tie valve was partially opened to provide back-up Instrument Air supply. The 3C Instrument Air Compressor was aligned to supply Unit 2.

Immediate corrective actions were to investigate the cause for loss of instrument air. Prior to returning the 3A Instrument Air Compressor to service, the following corrective actions were taken: replacement of the dryer inlet and exhaust valves and their solenoid relief valves, replacement of the cross-tie valve air pressure regulator and solenoid relief valve.

C. Apparent Cause of Event:

This report is submitted in accordance with Title 10 of the Code of Federal Regulation Part 50 Section 73 (A) (2) (IV), which states that any event that results in unplanned manual or automatic actuation of any engineered safety feature, including the Reactor Protection System (RPS) [JE] must be reported. As any engineered safety feature, including the Reactor Protection System (RPS) [JE] must be reported. As stated previously, a manual reactor scram was

initiated due to low instrument air header pressure.

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I. The root cause for Loss of Instrument Air is attributed to (1.) mechanical failure of the 3A Instrument Air Dryer inlet valve to close concurrent with (2.) failure of the backup Unit 3 Service Air to Instrument Air cross-tie valve to promptly open on low (air pressure. Contributing to this event is (3.) procedure weakness in failing to identify acceptance requirements and corrective actions for cross-tie valve operation during operability surveillance DOS 4700-01. Also contributing to this event was (4.) lack of management attention in failing to initiate prompt corrective action following quarterly cross-tie surveillances performed on October 5, and December 28, 1992.

3A Instrument Air Dryer Blow Down Investigation:

A review of the Instrument Air Transient Analysis Recorder Plot (TARP) was performed as part of the initial scram investigation,. The Instrument Air header time decay trace was compared against the 3A Instrument Air Dryer operating cycle (Figure 2). The right chamber inlet valve closes at time zero. At 5 seconds, the right chamber blowdown (purge) cycle is initiated with the exhaust valve opening. The exhaust cycle continues for 245 seconds, after which the exhaust valve closes. Chamber repressurization commences approximately 3 seconds later and lasts for 33 seconds. At the end of the repressurization phase, the right chamber inlet valve opens for the drying cycle of 313 seconds. During the right chamber drying phase, the left chamber processes through the same blowdown and repressurization cycles. One complete dryer cycle lasts 6 minutes after which time the process repeats.

Review of the Instrument Air Transient Analysis Recorder Plot (Figure 1) indicated air header pressure continued to decay from time 0 to 178 seconds after which the header pressure began to recover. Recovery is believed to have resulted from the back-up Service Air to Instrument Air (SA/IA) cross-tie valve opening. Header pressure began to increase rapidly and stabilized at approximately 75 psig. At 250 seconds, the header pressure again started to increase to approximately 95 psig at 310 seconds. For the next 390 seconds air header pressure varied between 100 and 105 psig (operating on the

Service Air system pressure).

Upon receipt of the instrument air low pressure alarm, Operations personnel were dispatched to identify and abnormal conditions; the SA/IA cross-tie valve was found full open, the 3B IAC was found running unloaded with its air receiver at 30 psig. The 3A IAC was found running loaded; however, the 3A IA dryer alarm was illuminated and the dryer bypass was open. The Operator reset the 3A IA dryer alarm and bypass and reset the SA/IA cross-tie valve to close. The 3B IA compressor started loading as expected and the 3A IA dryer was observed to operate without trouble for several cycles.

Based on a review of the dryer operating cycle, review of the TARP time-line and conditions observed by operators on the Unit 3 instrument air system, it was determined that a dryer inlet valve failed in the open position for one drying cycle. With an inlet valve failing open, low air header pressure would be observed for 245 seconds during the purge cycle. The TARP time-line corroborates this condition. If the inlet valve remained in the failed open position, low air header pressure would have been observed 355 seconds later on the subsequent chamber purge cycle; this did not occur. If a dryer exhaust valve failed in the open position, air header pressure decay would have been observed for 313 seconds during the chamber drying cycle; this condition also did not occur.

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1. Dryer Inlet Valve Failure Analysis:

Focusing on the dryer inlet valve as the root cause for loss of instrument air, three failure modes were investigated as indicated on Figure 3. The failure path is identified for one dryer chamber; however, it equally applies to both chambers. The three failure modes investigated were:

- a. Dryer timing circuit malfunction.
- b. Inlet valve pilot solenoid failure to energize closing the dryer inlet air operated valve.
- c. Air operated inlet valve failure to stroke.

a. Dryer Timing Circuit Malfunction

The dryer timing motor and circuit was inspected by the factory service representative on February 1st and 4th. The timing motor was found to be running hot; however, its operation was acceptable. The timing cam assembly was found to rotate freely with minimal resistance. Resistance measurements were taken across relay contacts with all readings within limits (0.2 ohms) except one contact which read approximately 4 ohms. The high resistance reading occurred on one of the exhaust valve contacts. The service representative indicated contact failure is typically not corrective and would have appeared on subsequent cycle operations. Based on the above, dryer control circuit malfunction was ruled out as a probable cause for dryer inlet valve failure.

b. Inlet Pilot Solenoid Valve Failure

Intermittent pilot solenoid valve failure to energize would result in the inlet valve failing in the open position. Station Electrical Maintenance and factor service representative experience indicates that solenoid valve malfunction typically is non-corrective, or as a minimum would be repeated following a malfunction. The solenoid pilot valves continued to operate without problems for several hours following the loss of instrument air transient until their replacement later on January 16. Based on these factors, pilot solenoid valve failure was ruled out as a probable cause.

c. Air Operated Inlet Valve Failure

Intermittent failure or binding of the inlet AOV, 2 port ball valve, would cause loss of instrument air if the valve failed in the open position during the chamber purge cycle.

On January 16, the two port dryer inlet and exhaust valves were replaced with single port fail-safe valves. On February 1st, the replaced valves were bench tested to determine valve operability. Both exhaust valves operated freely in the open and close positions with air applied to their respective ports. One inlet valve was found to operate freely in the open and closed positions; however, the remaining inlet valve failed to move to its closed

position. The valve was manually closed and air was reapplied. In each attempt the valve either remained open or stuck in a partially open position. Silicone spray was then applied to valve ball. The valve then moved to both the open and closed positions; however, movement had noticeable resistance. Successful valve actuation following lubrication demonstrated that valve actuator was operating properly. The failed valve had not been altered during the 15 day period that it was removed until testing on February 1, 1993.

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Based on bench testing it was determined that inlet valve binding in the open position was the root cause for dryer blowdown.

2. Service Air to Instrument Air Cross-Tie Valve Failure Analysis:

Review of the TARP time-line indicated the Service Air to Instrument Air cross-tie valve remained closed for approximately 150 seconds following the low instrument air header pressure alarm. Figure 4 provides a schematic diagram of the cross-tie air operated valve (AOV), valve air regulator, solenoid operated relief valve (SOV) and instrument air low pressure switch. The low pressure switch is set to energize the SOV at a header pressure of 85 psig. The SOV relieves pressure from the SA/IA cross-tie valve operator through the valve pressure regulator. The pressure regulator is set to maintain 30 psig on the cross-tie valve operator. Operating Surveillance DOS 4700-01, Quarterly Service Air to Instrument Air Auto Cross-Tie Test, was performed several times to establish the as-found cross-tie valve opening time and to trouble shoot possible failure modes. Four possible failure modes were evaluated for slow cross-tie valve response: a. Solenoid relief valve operation, b. pressure switch operation, c. Pressure regulator operation and, d. Cross-tie operation under simulated dryer inlet valve failure.

a. Solenoid Relief Valve Operation.

On January 16, 1993 at 0251, DOS 4700-01 was performed to measure cross-tie valve stroke time from a low pressure initiation signal. The cross-tie valve started to open

approximately 120 seconds following SOV actuation and was fully opened 20 seconds later. The SOV was replaced and the surveillance performed a second time during shift 1 on January 17. Similar results were obtained. Based on the repeat occurrence with a new relief valve, SOV failure was dismissed as a probable cause for slow cross-tie valve response time.

b. Pressure Switch Operation.

Following SOV replacement, Electrical and Instrument Maintenance personnel tested the pressure switch actuation set point and pressure switch contact to SOV actuation time delay. Pressure Switch (PS 3-4741-3) was verified to made contact at 85 psig and zero time delay was observed from SOV actuation vs. pressure switch contact closure. As a result, pressure switch and SOV malfunction were eliminated as probable cause for slow cross-tie valve response time.

c. Pressure Regulator Operation.

Having eliminated the Pressure Switch and AOV as probable failure modes, attention was placed on the cross-tie valve pressure regulator. The surveillance was performed several more times, each time tapping on the cross-tie valve pressure regulator. With each attempt, the cross-tie responded more rapidly with the final stroke time of approximately 25 seconds from the low pressure initiation signal. The pressure regulator was replaced and testing resumed on January 17, shift 3. Three stroke times were performed and the cross-tie valve achieved full-open in approximately 25 seconds for each test.

The root cause for cross-tie valve slow response time is attributed to air regulator operation.

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During these tests it was observed that the cross-tie valve did not open sufficiently to pass service air until regulator pressure dropped to approximately 12 psig. Regulator pressure decay was constant while venting through the solenoid valve. It is believed that more

rapid cross-tie response could be achieved by locating the solenoid relief valve upstream of the AOV pressure regulator.

d. Cross-Tie Valve Operation Under Simulated Dryer Inlet Valve Failure.

On January 18, at 1911 hours, a Special Procedure (SP 93-1-6) was performed as part of the Start-Up On-Site Review. The SP was performed to demonstrate the ability of the cross-tie valve to open and maintain instrument air header pressure with a failed open dryer inlet valve. This test would simulate the initiating failure which led to the January 16, loss of Instrument Air. Successful performance of this test would demonstrate adequate cross-tie valve operation for post scram reactor start-up.

During this test, the right dryer inlet valve was forced to fail in the open position during the right chamber purge cycle. A low air pressure signal was initiated by bleeding air from the air receiver mercury pressure switch. Air receiver pressure was recorded every 15 second during the transient. The mercury pressure switch was observed to actuate at approximately 85 psig. The cross-tie valve was observed to be fully open approximately 26 seconds following low pressure signal initiation. The Transient Analysis Recorder was used to plot the instrument air pressure profile. The TARP profile (Figure 5) indicates that pressure dropped to approximately 78 psig sixty seconds following blowdown initiation. Approximately 30 seconds elapsed from header pressure of 85 psig to the time where header pressure began to recover. Header pressure stabilized at approximately 90 psig until 260 seconds had elapsed, at which time the dryer exhaust valve closed and pressure returned to 95 psig. The test was terminated, the dryer was returned to normal operation and the cross-tie valve closed. Based on the favorable results, cross-tie valve operation was found acceptable for Unit 3 Start-Up.

The Root cause for cross-tie valve slow response time is attributed to air regulator operation.

3. Contributing Cause - Procedure Weakness:

Procedure weakness in failing to specify acceptance criteria

for valve stroke time and management deficiency for failing to promptly correct slow valve response time contributed to cross-tie valve failure.

Quarterly Operating Surveillance DOS 4700-01 records air pressure on the cross-tie air pressure sensing line at the time the cross-tie valve opens. The sensing line has minimum air volume which is bled down significantly from the time the cross-tie pressure switch actuates and the cross-tie valve fully opens. This surveillance should more appropriately record pressure indication at the time the pressure switch actuates. The surveillance does not record cross-tie valve stroke time or specify a minimum stroke time acceptance criteria.

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4. Contributions Cause - Lack of Management Attention:

Unit 3 cross-tie operating surveillance (DOS 4700-01) was performed on October 5, 1992. Comments section on the procedure cover sheet indicated the valve was slow to open. Work request D13057 was written that same day to investigate the cause for slow valve response. The work request indicated the valve took over 1 1/2 minutes to open. The work request was assigned a B3 priority. On December 28, DOS 4700-01 was again performed on Unit 3. The surveillance did not identify stroke time problems; however, the center desk log for that date indicated the cross-tie opened very slowly, approximately 1 minute, and questioned if the valve would open in sufficient time to save instrument air if required. Work Request D15121 was written to adjust the cross-tie valve to correct leakage.

Had attention been promptly applied to investigate and correct cross-tie valve slow response time when it first became apparent in October, the loss of instrument air on January 16, 1993 could have been avoided. This deficiency applies to work request prioritization and Management awareness of system operational problems.

II. SBT 'B' Train Trip

During the Unit 3 manual scram, SBT received its automatic

initiation signal as expected on Reactor Vessel water level. At the time, 'B' train was in primary and 'A' train in standby. The 'B' train started as expected. Approximately 3 minutes after initiation, the 'B' train tripped and 'A' train started.

The running SBTG train will only trip under two conditions:

1. Either low train air flow (below 2390 cfm)
2. Or loss of train heater operation.

Approximately 8 hrs after the event, SBTG 'B' train was started to try to recreate the failure. The train ran flawlessly (Instrument air pressure was normal, 95 psig) at which time the following were observed:

All relay coils and contacts were proven to be in working order.

All dampers, the fan and fan motor were proven to be operable.

The reason for the train tripping is because of the reinstating of full instrument air pressure:

When instrument air pressure drops below 78 psi a pressure switch activates causing the SBTG train flow controller to lose control of the flow control valve (FCV) and the FCV fails to the full open position. This full open condition allows SBTG to operate at a flow which is greater than the flow controller setpoint. While in this condition the controller is trying to close the valve in order to maintain proper flow, thus pressure is building up on the controller output. When instrument air pressure increases above 78 psig the pressure switch reactivates allowing the flow controller to resume control of the FCV. Because of the large position error created when the FCV is full open, the controller forces the FCV to close as hard as it can resulting in an overshoot. This overshoot causes the flow to drop below the low flow setpoint, which causes the standby train to initiate and trip the running train.

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D. Safety Analysis of Event:

The purpose of the Instrument Air System is to supply clean, dry air at the required pressure for valve and instrument control on the associated unit. Loss of instrument air header pressure is a significant event which in this instance required operations to initiate a manual reactor scram. Following the manual scram, the Unit 2 and Unit 3 Reactor Building Ventilation Systems auto isolated and the unit 2/3 B Standby Gas Treatment System auto started on a Group II Isolation. The inboard and outboard MSIVs were isolated. Reactor water level and pressure were manually controlled by placing the Reactor Water Cleanup and Isolation Condenser Systems in service. All safety systems performed acceptability. The safety significance of this event was minimal.

E. Corrective Actions:

Immediate corrective actions were to dispatch operations personnel to investigate the cause for the low air header pressure alarms. The Unit 3C Air Compressor was verified operating properly. The 3A dryer trouble light was illuminated with the dryer bypassed, the 3B IAC was running unloaded with its air receiver at 30 psig, the main air receiver was indicating 105 psig, and the Unit 3 SA/IA cross-tie valve was found full-open. Operations personnel proceed with a normal plant scram recovery.

An event investigation was initiated to identify the proximate and contributing causes and to identify corrective measures to prevent recurrence.

Prior to returning the 3A Instrument Air Compressor to service the following corrective actions were taken:

- o replacement of the 3A dryer inlet and exhaust valves,
- o replacement of the inlet and exhaust solenoid valves,
and
- o replacement of the cross-tie valve air pressure
regulator and solenoid relief valve.

Summary of Corrective Actions

1. Instrument Air:

- a. A Special Procedure will be written to evaluate SA/IA Cross-tie valve stroke time on rapid bleed of the valve

air operator upstream of the valve air regulator. If this test demonstrates improved valve response time a work request will be processed to relocate the solenoid relief valve upstream of the Cross-tie valve air regulator. This will be completed by July 1, 1993. (2491809300401)

b. The cross-tie valve surveillance procedure DOS 4700-01 will be revised to incorporate appropriate acceptance criteria by June 1, 1993. (2491809300402).

c. A preventive maintenance program will be established to inspect dryer components, specifically: dryer control circuit, inlet and exhaust valves, discharge and purge check valves by August 1, 1993. (2491809300403).

d. The dryer bypass pressure switch will be evaluated to raise its set point above the current 60 psig by June 1, 1993. (2491809300404).

e. Operations Management will emphasize the importance of promptly performing corrective action on Instrument Air deficiencies having the potential to impact instrument air system integrity by April 1, 1993. (2491809300405)

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2. Standby Gas Treatment System Performance:

a. The response of the SGBT flow control on a loss of IA and subsequent recovery will be included in licensed operator required reading by June 1, 1993. (2491809300406).

F. Previous Occurrences:

LER/Docket Numbers Title

12-3-90-47 Instrument Air Header Pressure Loss Via 3A
Instrument Air Dryer Due to Management
Deficiency

This event involved failure of an exhaust valve to close following valve replacement. The dryer had been taken out-of-service to replace the four air operated switching

valves. While removing the outage, the operator noticed one blowdown valve remained open. With the dryer valved in and the blowdown valve stuck in the open position, air receiver pressure dropped. Investigation determined that two air supply lines to the exhaust valve had been reversed during installation of the new switching valves. Corrective action was to properly connect the air supply lines.

G. Component Failure Data:

The Instrument Air System is not NPRDS reportable. A NPRDS search was performed, no data was obtained.

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Figure 1 "Transient Analysis Recorder Plot Unit 3 Instrument Air Receiver Pressure (12:13:55 Through 12:20:55 January 16, 1993)" omitted.

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Figure 2 "Unit 3A Instrument Air Dryer Timing Circuit" omitted.

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Figure 3 "Unit 3A Instrument Air Dryer Failure Mode, Air Release Paths" omitted.

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Figure 4 "Unit 3 Service Air To Instrument Air Cross-Tie Valve Control Schematic" omitted.

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Figure 5 "Transient Analysis Recorder Plot, Unit 3 Instrument Air Receiver During Simulated Failed Open Inlet Valve" omitted.

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February 15, 1993

CWS LTR #93-0084

U. S. Nuclear Regulatory Commission
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Licensee Event Report 93-004, Docket 0050249 is being submitted as required by Technical Specification 6.6, NUREG 1022 and 10 CFR 50.73 (a)(2)(iv).

Charles W. Schroeder
Station Manager
Dresden Nuclear Power Station

CWS/tsc

Enclosure

cc: A. Bert Davis, Regional Administrator, Region III
NRC Resident Inspector's Office
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